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FAO Plant Protection Bulletin

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World Reporting Service on Plant Diseases and Pests

Cotton Spraying in the Sudan Gezira

II. Entomological Problems Arising from Spraying

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Crop yield is an expression by the plant of the interaction of many factors in its environment, and the improvement in yield brought about by spraying is a result of multiple changes in this complex of factors, the elucidation of which is the object of much of the present program of research. Preliminary examination of available data suggests that a linear relation may exist between the infestation of cotton jassid (*Empoasca lybica* Berg.) and yield, but this work is far from complete. Even if such a relation were established it still would not be possible to infer that jassids alone were involved in the increase in yield which accompanies spraying. It was, however, the relatively disappointing results obtained from spraying cotton in the southern part of the Gezira Scheme which directed attention to the need for studying the changes in the environment and growth of the plant that were brought about by spraying.

Two main varieties of *Gossypium barbadense* are grown in the Gezira, X1730A which is leaf-curl resistant and is grown in the wetter southern areas, and Domains Sakel which is leaf-curl susceptible and is grown in the drier north. Snow and Taylor (4) found in their analysis of the 1949/50 data that the increase in yield due to spraying was different in different districts and concluded that the increase for any variety-manuring-district-combination could be adequately represented as the sum of two components, one characteristic of variety-manuring-combination and the other characteristic of the district. A simplified expression of their conclusions is as follows:

Season 1949/50 – yield increase from spraying

(*a*) Component due to variety and manuring:

Domains Sakel, manured	1.66 k.p.f. [1]
X1730A, manured	2.23 k.p.f.

(*b*) Component due to district:

Northern half Gezira	+ 0.16 k.p.f.
Southern half Gezira	— 0.36 k.p.f.

It was expected therefore that the smaller response to spraying in the southern half of the Gezira would be fully compensated by the better response of X1730A to spraying. This expectation was not realized during the years in which an extensive spraying program was applied to the south. The mean increases in yield obtained for the two varieties in the Gezira experiments during the years in which there exist comparable data (5 years in the case of X1730A and 6 years in the case of Domains Sakel) were, in fact, as follows:

Southern areas:	X1730A	0.59 k.p.f.
Northern areas:	Domain Sakel	1.41 k.p.f.

In three years out of five, the increase in yield recorded in X1730A could have been due to chance, but in all years the increase of yield in the Domains Sakel was significant. Consideration of long-term trends,

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[1] k.p.f = Kantars per feddan. One kantar = 315 rotls or 312 lb. seed cotton yielding approximately 100 lb. lint of Domains Sakel or 107 lb. lint of X1730A. One feddan = 0.42 hectare or 1.038 acres.

however, indicates that the cotton yields of Southern Gezira have deteriorated during the last pentad, a period which roughly corresponds with the introduction of large-scale spraying in this area. In view of this and of the lack of clear experimental evidence to the contrary the wisdom of routine spraying in the southern Gezira has been questioned.

Not only has increase in yield from spraying been disappointing in the southern Gezira but it is alleged that a general decline in the average grade of cotton from the Gezira has coincided with the advent of spraying. Some decline in average grade was to be expected because spraying, like the use of nitrogenous fertilizers in the Gezira, extends the fruiting of the crop and later pickings of cotton tend to be graded lower than the earlier ones. But the main reason for concern is the almost complete absence during the last three years of all top grade cotton. It is by no means certain, however, that there has been a general decline in grade which can be attributed to spraying. There were good seasons with a high return of top grades and bad seasons with a low return of top grades before the spraying program was initiated. There have been similarly good and bad years since spraying was instituted and no clear pattern of increased tendency in one direction or another is at present discernible.

There nevertheless appear to be entomological reasons why spraying could affect adversely both cotton yield and grade, and these will now be examined.

Both a district and a varietal effect are apparently involved in the poor response in the southern parts of the Gezira and neither has yet been elucidated. The districts differ considerably, in that the insect regime is far more complex in the south than in the north, and the climate of the south is more favorable for the cotton whitefly (*Bemisia tabaci* Genn.), cotton thrips (*Hercothrips* spp.) and the American bollworm (*Heliothis armigera* Hbn.). Infestation of cotton jassid is generally greater in the north than in the south. This is particularly marked if the numbers per leaf are recorded, this being a measure of the infestation. But the numbers per plant, which is the measure of the population per unit area of land, are by no means invariably greater in the north than in the south as the variety X1730A frequently has 2 to 3 times as many leaves as Domains Sakel. Snow and Taylor (4) concluded that the component due to district was probably derived from this greater infestation in the north than in the south. They also suggest that the greater response to spraying of X1730A, demonstrated in the component due to variety and manuring, was to be expected from this variety, which has basically a higher yield. Further work, however, has suggested that X1730A is more tolerant of jassids than Domains Sakel and therefore the destruction of this pest on the former gives a smaller response than its destruction on the latter variety. More precise information is being compiled on the effect of X1730A of various levels of jassid population.

Two other important pests, viz. cotton whitefly and American bollworm may, however, be involved.

Cotton Whitefly

Much concern has been expressed at the increase in whitefly numbers which frequently accompanies spraying. Since this is of much more regular occurrence in the south than in the north, and on X1730A than on Domains Sakel, this increase in withefly has been held to be a major reason for the disappointing results obtained from spraying X1730A. Investigation of the feeding habits of the cotton whitefly and of some of its effect on the growth of the cotton plant have recently been reported by D. Pollard (in press). In 1952, the writer, in a randomized and replicated experiment over 900 feddans, destroyed whitefly by spraying with parathion. The resultant yield increases are summarized in Table 1.

TABLE 1. *Control of cotton whitefly by parathion spray on cotton variety X1730A* [a]

Frequency of spraying	Yield		Yield increase, k.p.f.
	k.p.f.	percent	
0 (check)	3.96	100	—
1	4.99	126	1.03
2	5.32	134	1.36
3	4.92	124	0.96

[a] Standard error = ±0.22 k.p.f.; least significant difference (P =0.05), 0.45 k.p.f.

At least part, perhaps the bulk, of this very considerable increase in yield, over and above that obtained from DDT spraying, may be attributed to whitefly destruction. It is also important to record that parathion

spraying resulted in substantial increase in lint length, lint index, weight of seed cotton per boll, and seed weight.

It could be inferred from these experimental results that October infestations of whitefly affected yield and November infestations quality of lint, corresponding to the seasonal development of the cotton plant described by Crowther (3).

The evidence from this and from several small-scale experiments carried out on the Gezira Research Farm and on the White Nile have led to the conclusion that whitefly can be responsible for an important reduction in cotton yield and that they may affect grade. Pollard has shown that whitefly feed on the phloem of the leaves, but do not sensibly injure the plant mechanically or chemically. Whitefly are numerous on cotton during October and November, when, according to Crowther (2), most of the vegetative growth takes place. They are thus removing from the plants products of assimilation and thus reducing the amount available for storage. Their effect is only likely to be apparent when stored material is being mobilized for maturation of fruit, although this occurs at a time when the whitefly is almost completely absent from the crop. On plants which have been badly attacked the development of fruit ceases prematurely and is accompanied by shedding of immature bolls and even fruiting branches, a condition consistent with a deficiency of stored nutrients. A plant kept free from whitefly sheds fewer bolls, few branches, and matures more fruit. The severely attacked plant shows early signs of senescence (e.g., development of anthocyanin pigment in leaves and stems) which come measurably later in plants kept free from whitefly.

This partial elucidation of the status of whitefly has led to an examination of the major factors which affect its annual incidence, and the effect of spraying on its numbers. Since this work is still in progress the conclusions expressed here must be considered provisional.

There is no doubt that the numbers of whitefly are frequently increased by DDT spraying, but there is also no doubt that it is not possible to induce epidemic numbers by spraying alone. An over-all favorable climate is necessary for the whitefly infestations to become epidemic. The climate of the Gezira is determined by the passage of the Inter-tropical Front to which the northerlies (N. E. Trades) and the southerlies (S. E. Trades) converge. Whitefly breed rapidly during months when the air is derived from the southerlies (the rainy period) and slowly when the air is derived from the northerlies (the dry season) unless the air is greatly modified by prolonged contact with heavily irrigated soil. The passage of the Inter-tropical Front through the Gezira occurs during the second half of October or first half of November. Various conditions which delay the passage of the north wind over the damp soil, such as closeness of canopy and wind breaks, may be termed shelter. The writer analyzed the distribution of whitefly in a crop in which sowing dates were randomized and obtained results which are summarized in Table 2.

TABLE 2. *Distribution of whitefly (immature stages) on cotton plants in relation to wind-shelter and sowing date*

Environment	Mean number of insects per 100 sq.m. of leaf surface	
	Plants sown in July	Plants sown in August
Exposed to north wind	614	126
Sheltered from north wind, high on plant	10,153	930
Near damp ground	42,330	7,620

For analysis of variance the counts obtained from individual replicates were transformed logarithmically. The numbers of whitefly recorded on July-sown cotton were significantly greater at all levels than on August-sown cotton, and the numbers recorded on cotton sheltered from the north wind were significantly greater than on cotton exposed to the north wind. There was no interaction between sowing date and exposure. The most favorable site for immature stages of whitefly was on young leaves, near the damp ground, but exposed to the sun; here numbers were nearly 70 times greater than on young leaves exposed to the sun and wind. Although numbers were so much greater on July than on August-sown cotton, parts of the early sown plant exposed to the wind supported only 10 percent of the population found on leaves in the most favorable site on late-sown plants. Other factors which favored whitefly numbers were nitrogenous fertilizers and

leaf-hairiness, but a pre-requisite for their development was shelter of the site from the north wind.

The physical environment of the immature stages of the whitefly is determined by the properties of the 0.1 mm. thick layer of air on the lower surface of the leaves. No measurement of the properties of this air has been attempted, but it may be assumed that its main characteristic is a high vapor pressure. Modification of this characteristic will be affected by (i) the velocity of the ambient air and (ii) the vapor pressure of the ambient air. Since the northerlies are strong and very dry they will have a greater effect on the environment of the immature stages of whitefly than the southerlies which are so much gentler and damper. A dense leaf canopy and frequent watering will impede the wind velocity and modify the dry characteristic of the northerlies, creating conditions favorable for whitefly within the more or less closed environment of the crop. A season will therefore be favorable for whitefly if through early sowing, or strong vegetative growth, or late arrival of the northerlies, the crop has completed a dense canopy before the passage of the Intertropical Front to the south.

Having emphasized this overwhelming influence of climate, the effects of spraying of DDT on whitefly numbers may now be considered.

In the absence of spraying and under favorable climatic conditions, enormous numbers of whitefly breed up in the crop, occasionally reaching several hundred eggs and nymphs per square cm. of leaf surface and several score of adults per leaf. Peak populations are reached between the end of October and the end of November, depending on the season and site, and thereafter numbers decline rapidly. The reasons for this decline are not known but are certainly a complex, the climate, the competition with jassids, the state of maturation of the plant, and the incidence of predators and of the parasites *Eretmocerus* and *Prospaltella* spp. all playing a part.

The effect of normal commercial application of DDT is to cause high mortality amongst adult whitefly but, owing to the limited coverage of the under surface of the leaves achieved by standard practice, few nymphs are killed. The survival rate of the nymphs, on the contrary, is increased and if climatic conditions are favorable for breeding, populations not only recover but soon surpass those on unsprayed cotton. Furthermore, the seasonal decline in numbers may be delayed by several weeks. The net effect of this increase in whitefly numbers has been measured on several occasions and has been found to result in a sprayed crop experiencing about twice the infestation (as measured by whitefly numbers × days) as that of an unsprayed crop in a similar site. The significance of this finding cannot be described precisely until more is known of the relationship between infestation and yield and between infestation and grade. It is likely, however, that in a season or site unfavorable for whitefly this increase is of little importance, but when conditions are favorable for whitefly important losses from this pest would occur even in the absence of spraying. It is probable, however, that the effect of spraying is to increase the incidence of epidemic numbers.

The reasons for the increase of whitefly after spraying with DDT are not known and are certainly manifold. Although the incidence of parasitism is small, ranging from 5 to 10 percent of the nymphal population, M. R. Norman has recently found that *Eretmocerus* sp. attacks only late instar nymphs. If the number of parasitised nymphs is expressed as a percentage of the number of late instar nymphs, 90 or even 100 percent parasitism may be recorded. These parasites are killed by spraying and although recolonization occurs, it is slow. Thus spraying may be regarded as removing a barrier to the normal development of the whitefly. At the same time there is firm evidence of competition between jassids and whitefly, a competition normally won by the jassids which damage the leaf so seriously. Removal of jassid competition would inevitably result in increased whitefly even if parasites were not involved. Again, spraying increases the vegetative vigor of the plants, which are taller, carry more leaves, and have larger leaves than unsprayed plants. This dense canopy of foliage itself creates a favorable environment for whitefly. The relative importance of these and other factors has still to be elucidated.

It is clearly desirable that a method for control of whitefly should be achieved as early as possible. Numbers may be reduced by delaying the date of sowing. This has been done during the present season with beneficial effects, although the season has been one climatically favorable for whitefly. Whitefly may be killed by incorporating parathion in the spray. As shown by Norman, parathion is translocated across the lamina of the leaf, so that spray droplets falling on the upper surface cause the death

of whitefly nymphs feeding on the lower surface. Parathion spraying, however, has drawbacks, which will be discussed later. Norman has also found that DDT is effective against whitefly nymphs as a contact insecticide and has emphasized the importance of obtaining a good coverage of the under-surface of the leaf. One method of achieving this is to return to high volume spraying and experiments carried out during the present season confirm the value of this approach.

American Bollworm

American bollworm is present in the crop from mid-October, when flowering begins, until the end of December, when flowering is finishing. Its maximum incidence is low on both sprayed and unsprayed cotton, seldom exceeding one larva per plant-hole (i.e., 11,000 larvae per feddan) and usually very considerably less. Spraying, however, appears to result in a temporary increase in the numbers of buds shed in association with the damage caused by this bollworm. One effect of spraying is that sprayed cotton frequently carries less bolls on its lower branches than unsprayed cotton. This greater proportionate loss of first formed buds by sprayed cotton may well have a beneficial effect on yield similar to that described by Crowther (1) who was able to produce significant increase in yield by removing all buds produced up to mid-November. At the same time, since the best grade cotton is expected from the first fruit, this loss may be regarded as undesirable. Although there is no evidence that spraying has resulted in any loss of crop through increased damage by the American bollworm, this is a possibility which must be watched with close attention. That this can happen was demonstrated by the writer in experiments in which whitefly was controlled by parathion spraying. In this experiment, parathion, which destroyed young larvae of the American bollworm on hatching from eggs when sprayed onto cotton at a rate of 0.25 lb. active ingredient per feddan, reduced the number of the bollworm to 10,000 per feddan compared with 18,000 per feddan on the control fields sprayed with DDT only. Nevertheless nearly 10 percent more fruit was lost in association with the bollworm damage in the parathion sprayed treatments than in those not receiving a parathion spray. The probable explanation is that the smaller population of larvae in the parathion sprayed treatments had a higher survival rate than the bigger population in the treatments using only DDT. When this experiment was repeated the following year the increased damage from the American bollworm after parathion spraying was so great that in many replicates almost all fruit formed until the end of December was lost in association with this pest. Much of the benefit that the plant obtained from the destruction of whitefly was lost from increased damage by the American bollworm.

Other bollworms which attack cotton in the Gezira, *Earias insulana* Boisd. and *Platyedra gossypiella* Saund., appear to be little affected by spraying, but the American bollworm must be carefully considered in any modifications to the spraying schedule.

Discussion

The Sudan Gezira has been fortunate in having been able to apply insecticides in the control of cotton jassid with so little disturbance to the pest complex associated with the crop. The basic reason for this no doubt lies in the climate, which demands of its fauna the ability to maintain its numbers by rapid breeding during a rainy season which may last from 3 to 6 months, in order to surmount the high mortality which follows during a dry season of the utmost physical and biological severity, of 6 to 9 months duration. Many insects of the Gezira are scarcely able to maintain themselves under these conditions, and their parasites, which may be frequent in wetter areas, are often rare or absent in the Gezira. When a season occurs favorable to their breeding, numbers may increase to a fantastic extent in the absence of effective natural checks in their biological environment, giving rise to the epidemic outbreaks so characteristic of the area. The checks to insect numbers in the Gezira are normally to be expected in the physical and not in the biological environment. Irrigation is an extension of the favorable physical environment and is therefore conducive to the occurrence of epidemic numbers of insects. The cotton jassid is a typical instance of the formidable degree to which a pest may multiply in the absence of natural checks. Nevertheless the limiting of factors of the physical environment, now reduced by irrigation to a dry season of only 2 to 3 months duration, ensures that epidemic numbers are not carried over from season to season.

It is clear, however, that the biological environment, as provided by parasites and predators, cannot be completely ignored,

at least in the southern parts of the Gezira. If it is established, as is likely, that parasites and predators exert a major influence on numbers of whitefly and bollworm in the cotton crop, the Gezira Scheme is faced with a different problem, which can be resolved in one of three ways:

(i) the abandonment of spraying, which would entail the acceptance for the present of an appreciable loss of crop from the cotton jassid.
(ii) the development of "blanket" chemical treatments which will ensure the equal destruction of pest and beneficial insect.
(iii) the development of methods of selective destruction of insects associated with the crop.

The abandonment of spraying is not considered economically justified at present, even in the southern Gezira, until alternative methods of controlling jassids are discovered. Study of the ecology of the cotton jassid suggests that such methods may exist but they involve agronomic considerations which lie outside the province of the entomologist.

The development of "blanket" chemical treatments is fraught with dangers. Experiments have shown that both jassids and whitefly can be adequately controlled by an application of a mixture of DDT and parathion, followed two weeks later by a further application of parathion alone. Nevertheless, no insecticide has yet been discovered whose residual toxicity is such that it will destroy bollworm moths before they lay their eggs, and the danger deriving from the high rate of survival of the bollworm larvae in a crop thoroughly sprayed with powerful toxicants has been amply demonstrated in large-scale experiments. Such larvae could be reduced in number by including DDT in the second spray, but experiments have shown that repeated spraying with DDT encourages development of infestation by cotton aphid, which is not at present important in the Gezira. It is clear that once the remedy of powerful toxicants is adopted the corollary of repeated spraying must be accepted as a probability. Nevertheless the promising results in the control of jassids and whitefly obtained by a good under-leaf cover of DDT indicates that it may still be profitable to continue to explore this approach.

An alternative approach which is favored by the writer is the development of selective means of pest destruction. The most important pest to be controlled is the cotton jassid. Since its infestations are important only until the crop is 3 months old and plants can tolerate a considerable number of jassids during this period without suffering damage which is reflected in yield, complete destruction is unnecessary. Colonization of the crop by jassids is usually complete before serious numbers have developed so that damage can be attributed to the population breeding within the crop and not to invasion from outside. Long persistence of toxic residues may be less important than was previously considered. Nevertheless a persistence of 10 to 14 days is necessary to ensure destruction of nymphs which hatch from eggs after spraying. Work is, therefore, in progress designed to find with greater precision the maximum number of jassids the two varieties of cotton grown in the Gezira can tolerate without its effect being reflected in yield. Concurrently an investigation is in progress of the minimum quantity of insecticide of a limited persistency which is necessary to reduce the jassids to levels of no economical importance, together with a study of the minimum dispersal on the plant and within the crop which is required to produce the desired effect on these mobile insects. By this means it is hoped that it will not only be possible to reduce the cost of spraying but also to reduce jassid numbers, at the same time leaving reservoirs of parasites and predators within the crop. Since the increase of whitefly after spraying is certainly in part due to removal of jassid competition it may be necessary to incorporate in the spray an insecticide with little contact but with marked systemic or translaminar activity. Several such insecticides exist.

Such utilization of a chemical means to assist a biological process appears to the writer to be a sounder approach to the Gezira problems than an exclusively chemical one.

Summary

Most of the increases in yield from spraying cotton with DDT come from the northern Gezira and yield increases obtained in the southern Gezira have usually been disappointing. The reasons for these increases being lower than expected are discussed, and the need for further study of the status of cotton jassids emphasized. It is known that whitefly is considerably increased by spraying and evidence is given to show that this pest may be responsible for considerable losses in yields, by the direct effect of its feeding on the crop. While spraying does not itself create a serious epidemic of whiteflies, which

require favorable climatic conditions if they are to assume a pest status, it is argued that spraying may increase the incidence of epidemic seasons.

The factors governing this increase in whitefly numbers following spraying are also discussed. The important increases in yields resulting from spraying parathion to control whitefly are described but it is shown that in some seasons the benefit to the crop obtained by destruction of whitefly may be lost as a result of increased damage from *Heliothis armigera*. An account is given of the current approach to the problem of whitefly control.

Acknowledgments

The progress achieved in the elucidation of cotton pest problems in the Gezira has been made possible as a result of the close co-operation between the Gezira Board, commercial firms interested in Gezira spraying and the Entomological Section of the Research Division of the Sudan Ministry of Agriculture. The work has been organized by a Gezira Entomological Committee, under the chairmanship of Mr. R. C. Maxwell-Darling, Chief of the Research Division and directed by the writer in the capacity of Government Entomologist. The writer is grateful to the Chief of the Research Division, to the Sudan Gezira Board, and to the management and staff of Messrs. Pest Control Ltd., Plant Protection Ltd., and Shell Chemicals Ltd., for their co-operation over the years which has resulted in placing so many entomologists at the disposal of the Gezira Entomological Committee, thereby giving immeasurable assistance to this project.

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Plant Disease Situation in the United States [1]

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Yellow Bean Mosaic in Idaho

YELLOW bean mosaic caused by Bean Virus 2 is an important bean disease in Idaho and in other states of the Pacific Northwest. Its occurrence is associated with the principal host of the virus, white sweet clover (*Melilotus alba*). The virus overwinters in this host and is readily transmitted from it to beans (*Phaseolus vulgaris*). Sweet clover has been used extensively for some years as a green manure crop and has become a common roadside weed in most agricultural areas of Idaho. The disease is prevalent in sweet clover even in isolated areas far from cultivated fields. Since the virus is readily transmitted by several aphids, this wide distribution in sweet clover is to be expected.

A number of other wild and cultivated hosts for Bean Virus 2 have been reported, but sweet clover appears to be the principal host for the strain of the virus considered in this report. The typical symptoms on white sweet clover are shown in Figure 1. Careful study indicated that all of the several collections of the virus used, obtained from beans and sweet clover from locations in Idaho and from Prosser, Washington, were the type virus originally described by Pierce. [2]

Great variation was noted in expression of symptoms of yellow bean mosaic in field and garden beans and in peas. Symptoms

[1] This report is based upon material submitted by Collaborators of the Plant Disease Epidemics and Identification Section, Agricultural Research Service, United States Department of Agriculture.

[2] PIERCE, W. H. Viruses of the Bean. Phytopath. 24 : 87-115. 1934.

Figure 1. Typical mottling symptoms on leaves of *Melilotus alba* infected with yellow bean mosaic.

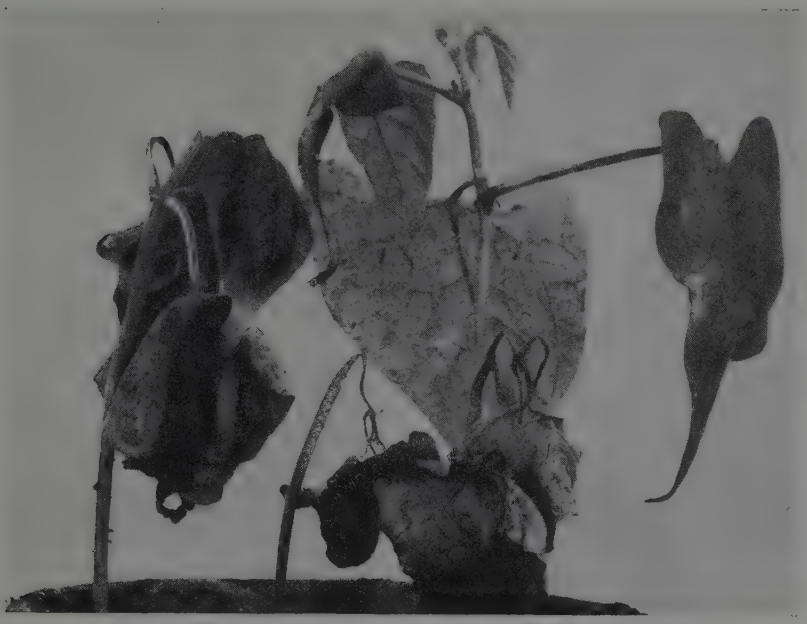

Figure 2. Bean yellow mosaic virus on the Multitinko variety of South American garden bean, showing the extremely severe effect on host growth. The plant on the right continued to grow and developed leaves with curling and mottling symptoms characteristic of yellow mosaic.

varied from slight mottling, through leaf curling and rugosity, to extreme stunting and death of plants. The extreme lethal effect of the virus on the Multitinko variety of South American garden bean is shown in Figure 2.

Artificial inoculations were made with the virus from infected sweet clover plants to a number of species of Leguminosae. As a result, five new hosts for the type strain of Bean Virus 2 were discovered. These are: *Vicia villosa*, *Lupinus densiflorus*, *Crotalaria spectabilis*, *Medicago lupulina*, and *Trifolium hybridum*.

Twenty-six horticultural varieties of peas were tested in the greenhouse for susceptibility to the type strain of Bean Virus 2. All of the varieties, except Perfection and Gem, were susceptible. Infection varied from 14 to 100 percent. The Perfection variety has previously been reported as resistant to this virus.

Among the bean varieties tested, Montana Great Northern Number 1 and Number 43-15, which have been reported to possess some resistance to yellow bean mosaic, were found to be as susceptible as University of Idaho Great Northern Number 123 and Number 59. All four selections were infected 100 percent and developed equally severe symptoms.

Digitalis Diseases in Wisconsin

A small acreage of *Digitalis lanata* has been grown commercially in Wisconsin since World War II with only minor losses from diseases. During the 1954 season, however, two diseases appeared which were destructive and caused the growers concern.

Anthracnose (*Colletotrichum fuscum* Laub.) was present in every field seen. Severity ranged from a few scattered leaf lesions to complete killing of appreciable numbers of plants in some fields by October. One field in the same area planted to *Digitalis purpurea*, how-

ever, showed only a small amount of anthracnose.

The other disease was a severe, malforming mosaic caused by tobacco mosaic virus. This was also present in every field seen. Sample counts in the most severely affected field showed over 50 percent of the plants infected. Some of these had mosaic patterns on all leaves, including the oldest, indicating early infection. On others symptoms were present only on the youngest leaves.

Inoculation tests show that most mosaic plants contained tobacco mosaic virus. A few contained what was apparently cucumber mosaic virus, and one yielded a virus producing ring-spotting on tobacco.

Since most *Digitalis* is grown by tobacco growers the presence of tobacco mosaic virus is not surprising. Previously, however, only a low incidence of virus diseases had been observed.

Disease Incidence in Castor Bean

Synchytrium gall. A stem gall disease of castor bean (*Ricinus communis*) was observed on the variety Cimarron in a commercial nursery at Cameron, Texas. The causal organism was tentatively identified as a species of *Synchytrium*.

Small red galls about 1 to 4 mm. in diameter (Figure 3) occurred on the stems, petioles and leaf blades of small seedling plants. In most cases these galls were so close together that they appeared to form a cylinder of hyperplastic tissue around the plant part affected. Individual galls each contained a single sporangium or resting spore depending on the stage of development. Stunting and chlorosis that accompanied these galls were probably caused by poor drainage rather than disease. Damage in the field was slight; only plants in poorly drained areas, where water

Figure 3. Red stem gall of castor bean, caused by *Synchytrium* sp. *Left:* a naturally-infected plant. *Right:* a healthy plant of same age.

had stood for a period of days, seemed to be affected.

Pleospora leaf spot. A species of *Pleospora* was found on senescent leaves of castor bean on three different occasions during the summer of 1954. Mature perithecia were found twice on the variety Cimarron at Gainesville, Florida, and once on the variety U. S. 101 at Plymouth, North Carolina. Perithecia were always well separated from one another and never were more than 20 found in a single lesion. The lesions were light tan in color with distinctly defined borders, usually not more than 5 mm. in diameter.

The relation of this fungus, possibly the perfect stage of an *Alternaria*, to a disease of castor bean is being investigated.

Charcoal rot. Charcoal rot (*Sclerotium bataticola* Taub.) has been reported on castor bean in India and Palestine but does not seem to have been observed on this host in the United States. During the summer of 1954, occasional castor bean plants naturally infected by charcoal rot were observed in Texas, South Carolina, Virginia and Maryland, and at Gainesville, Florida, at least 100 of 382 experimental plantings exhibited one or more plants affected naturally by this disease.

The above-ground symptoms are indistinct until mid-season, by which time infection has usually become well established. About this time, the stem at or about ground level may become discolored, usually blackened. Subsequent disease development under favorable environmental conditions leads to early death of the plant, still without pronounced external symptoms other than "early maturity." When the roots and lower stem are examined, multitudes of tiny black sclerotia are found beneath the epidermis, extending upward as far as the primary raceme (Figure 4). Upon splitting the stem, sclerotia commonly can be found in abundance in the pith.

The hot, dry weather, extending from June through August, following a normal, moist, warm spring, may partially explain the occurrence of this disease in such proportions at Gainesville in 1954.

Figure 4. Charcoal rot of castor bean, showing sclerotia of *Sclerotium bataticola* in the stem just below inflorescence.

The natural host range of *Sclerotium bataticola* is extensive but artificial inoculations have not been successful with all hosts. In a preliminary experiment, castor bean seed planted in sterilized soil was inoculated with a concentrated suspension of sclerotia from cultures. Two months after planting, sclerotia were found to be present in the roots of 96 percent of the plants, whether or not the plants were previously injured. In similar experiments, bean and sesame were found to be susceptible.

The castor bean fungus studied does not resemble Thirumalachar's *Sclerotium bataticola* subsp. *sesamica*, reported as having been isolated from castor bean but is closely similar to Reichert and Hellinger's subsp. *typica* as well as to Thirumalachar's illustration of *typica*.

Outbreaks and New Records

Canada

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THE following records of occurrence or establishment of insects new to Canada were made in 1953 and in all cases the records were believed to be new to North America as well. In many instances the insects were described as new species.

Aphid on Carrot and Chrysanthemum

The aphid *Myzus ascalonicus* Doncaster was collected from chrysanthemum cuttings stored in a cellar at Fredericton, New Brunswick, in 1953. It was very numerous, causing severe damage to the plants. Subsequently, specimens collected from a large population on carrot at Chilliwack, British Columbia, in 1947 were also identified as of this species.

Myzus ascalonicus was first observed in England in 1941 but was not described until 1946. It is common in that country on carrots in storage and on onion and other plants, in greenhouses and in the open. It is also reported to be an efficient vector of several plant viruses.

Aphid on Potato and Pansy

Winged viviparous and wingless oviparous females of an aphid, *Myzus certus* (Walk.), were collected from the common pansy (*Viola tricolor*) at Fredericton, New Brunswick. Specimens were reared through several generations on potato, establishing the first known record of colonization on this plant as well as the first record of the insect on this continent. The species is very similar to *Myzus persicae* (Sulz.).

Mealybug on African Violet

A mealybug, *Coccidella* sp., was collected in a greenhouse at Niagara Falls, Ontario, in old soil in which African violets had grown during the winter of 1948/49. Immediate control measures are believed to have eradicated the infestation. The insect is a potentially dangerous greenhouse pest and had not previously been reported in North America.

Eulophid Parasitic on Diamondback Moth

Several adults of a eulophid, *Tetrastichus sokolowskii* Kurdj., were reared from three cocoons of the diamondback moth, *Plutella maculipennis* (Curt.), at Ottawa, Ontario [1]. The absence of parasitic remnants indicated that the insect was a primary parasite. It was first reared from the diamondback moth in Russia and has since been recorded only from India.

Aegeriid on Poplar

An aegeriid, *Paranthrene tabaniformis* Rott., which occurs commonly as a nuisance pest in Europe, was reared from larvae found boring in twigs of *Populus* sp. at St. John's, Newfoundland.

Ambrosia Beetle in Orange Crates

Live adult specimens of a Japanese ambrosia beetle, *Xyleborus obliquecauda* (Motsch.), were intercepted in wooden orange crates at Vancouver, British Columbia, by officers of the Plant Protection Division. The species has been recorded from Ceylon and Japan and could possibly live in North America since *X. germanus*, a closely allied species from Japan, has become established in the States of New York and Connecticut, U. S. A., causing damage to grapes.

Coccinellids

Adults of two new species of Coccinellidae, *Coccinella fulgida* Watson and *Hippodamia parva* Watson, were found in 1948 crawling about on the sand at Cape Henrietta Maria on the northwest corner of James Bay, On-

[1] HARCOURT, D. G. A species of *Tetrastichus* new to North America. Canad. Ent. 85 : 251. 1953.

tario. The collector was unable to associate them with any particular plant or plant-feeding insects.

Aphid on White Spruce

A new species of aphid, *Cinara obscura* Bradley, was found in 1950 at Indian Head, Saskatchewan, in colonies on the bark of the lower stems of white spruce (*Picea glauca*) growing close together in seed-beds.

Aphid on Mock-orange

A new species of aphid, *Glendenningia philadelphi* MacGillivray, collected on *Philadelphus gordonianus* at Agassiz, British Columbia, is believed to represent a new genus. Only alate parthenogenetic females and nymphs bearing wing pads were present.

Leaf Miner on Arborvitae

A new species of leaf miner, *Argyresthia aureoargentella* Brower, was first noticed on arborvitae (*Thuja* sp.) at Fredericton, New Brunswick, in 1951. The species was collected in Charlotte and York Counties, nearly always in association with *A. thuiella* (Pack.), *A. freyella* Wlshm., and *Recurvaria* sp., possibly *R. thujaella* Kft.

Gouger on Sand Cherry

A new species of gouger of the genus *Anthonomus*, closely related to the plum gouger, *Anthonomus scutellaris* Auct., and said to be a composite, was reported from eastern Ontario. In this area the species restricts its activities to sand cherry (*Prunus pumila*).

Italy

Food Products Analysis Service
High Commissariat of Food, Rome

Incidence of Khapra Beetle in Stored Grain and its Eradication

The Entomological Laboratory of the Italian High Commissariat of Food recorded in 1953 that a coleopterous insect known as the Khapra beetle (*Trogoderma granarium* Everts) was found in wheat imported from Turkey and Syria by the Government. This insect has been reported as a major pest of stored grain in India and has several times been recorded as destructive in certain countries in Europe, but it has never been found before in storehouses in Italy.

When the presence of the Khapra beetle was ascertained in certain storages in Italy, even though only in small numbers, the High Commissariat took measures immediately to prevent its establishment and further spread. All storehouses in which the imported wheat from Turkey and Syria had been stored, even for a brief period, were thoroughly cleaned and sprayed with DDT or other synthetic organic insecticides. The wheat was disinfested by fumigation.

This introduced insect appears to have been eradicated, and up to January 1955 it had not been found again.

United States

Plant Pest Control Branch
Agricultural Research Service
United States Department of Agriculture

Grasshopper Outlook for 1955

Preliminary estimates indicate that approximately 6,000,000 acres of rangeland may require grasshopper control in 1955 in several states from Texas and Nebraska westward. Surveys in 1954 also showed that the greatest increase in grasshopper population in cropland areas occurred in some of the Mid-western and Western States, including parts of Indiana, Wisconsin, Iowa, Nebraska, Kansas, Minnesota, Missouri, Oklahoma, South Dakota, Texas and Utah.

Plant Quarantine Announcements

Canada

The Destructive Insect and Pest Regulations have been amended and consolidated by Order in Council P. C. 1954-2021 of 22 December 1954, published in the *Canada Gazette* (Part II) Vol. 89, No. 1, 12 January 1955. The Regulations established by Order in Council P. C. 2057 of 26 April 1949, as amended, are thereby revoked. The major changes introduced into the new regulations governing the importation and exportation of plant produce are as follows:

Part I – General:

1. *Interpretation of "nursery stock."* Aquatic plants from the United States, and seed potatoes and potato eyes from the United States other than from the States of Pennsylvania, Maryland and West Virginia, are excluded from the term "nursery stock," and therefore may enter Canada free of restriction.
2. *Interpretation of "pest or disease."* Earthworms of the family Lumbricidae used for fish bait or soil culture are excluded from the term "pest or disease," and therefore may enter Canada free of restriction.
3. *Powers of inspection.* Grain or grain products, maize and oil seeds are specifically mentioned under cereal exports, thus legalizing inspection and treatment of ships or other carriers carrying these products.

Part II – Admission of Plants into Canada:

1. *Certificate of inspection.* The certificate required to accompany each shipment of nursery stock originating in a country with an inspection service has been reworded to conform to the model certificate provided in the International Plant Protection Convention, and may include any special declaration which may be required under these regulations.
2. *Declaration on golden nematode.* With the exception of imports from the United States (including Hawaii and Alaska), Bermuda and the West Indies (including Cuba and the Bahamas), a special declaration is required for all shipments of nursery stock to establish: (*i*) that the nursery stock was grown under conditions apparently free from the golden nematode (*Heterodera rostochiensis*), as may be ascertained by official soil sampling or other investigation or, (*ii*) that in the country of origin this nematode is not known to occur.
3. *Plants with soil.* Prohibition of plants with sand, soil or earth, as well as sand, soil or earth and packings thereof, is extended to cover more countries. Countries from which such materials may be imported are as follows: the United States (including Hawaii, Alaska and Puerto Rico), the Netherlands, Belgium, Bermuda, the West Indies (including Cuba and the Bahamas) and Asia, and other countries which may later establish a golden nematode survey and control program and export certification policy. Plants with soil from Hawaii and Puerto Rico and from Asia are subject to restrictions previously established.
4. *Elm logs.* Elm (*Ulmus* and *Zelkova*) logs, bark or wood are exempted from the prohibition if they have been kiln-dried at 130° F. for 12 hours with relative humidity of 85 percent and are accompanied by a shipper's affidavit to this effect.
5. *Stone fruit stock from U. S. A.* The regulation has been amended to facilitate interpretation and to cover some virus diseases not previously included. All species, hybrids and horticultural varieties of sweet cherry (*Prunus avium*), sour cherry (*P. cerasus*), chokeberry (*P. virginiana*), Mahaleb cherry (*P. mahaleb*), Bessey cherry (*P. besseyi*), peach (*P. persica*), nectarine (*P. persica* var. *nectarina*), almond (*P. amygdalus*), apricot (*P. armeniaca*), plum (*P. domestica*) Japanese plum (*P. salicina*) and Damson plum (*P. insititia*), from the United States, including trees and propagating materials, must be accompanied by a certificate of inspection establishing that the nursery of origin was inspected during the growing season and is believed to be free from certain virus diseases. For cherry stock, the certificate must cover albino cherry, cherry buckskin, pink fruit and little cherry diseases if destined for British Columbia, and must cover, in addition to the four diseases mentioned above, twisted leaf if destined for other provinces in Canada. For other *Prunus* stock, the certificate must cover phoney peach, peach mosaic, yellow leaf roll, peach yellows and little peach diseases, if destined for British Columbia, and only the first three diseases mentioned above if destined for other provinces. This certificate requirement, however, does not apply to *Prunus* stock imported for scientific purposes, when a special permit has been issued.

   Cherry pollen and seed of stone fruit are now exempted from this special certificate requirement, but the latter still requires a permit and a general certificate of inspection.

6. *Fruit tree stock from countries other than U. S. A.* (*New regulation*). All species, hybrids and horticultural varieties of fruit trees, including trees and propagating materials of apple, apricot, cherry, nectarine, peach, pear, plum, prune and quince, from countries other than the United States must be accompanied by a certificate of inspection establishing that the material has been inspected and is believed to be free from such virus diseases as designated from time to time by the Destructive Insect and Pest Advisory Board. This requirement, however, does not apply to *Prunus* and *Pyrus* stock imported for scientific purposes, when a special permit has been issued.
7. *Broom corn from countries other than the U. S. A.* Importation of all broom corn from countries other than the United States is permitted only during the period 16 August to 14 May. The fumigation requirement to be carried out at Vancouver or Montreal is waived for whisks and toy brooms if the material used in manufacture is not large enough to carry larvae of stalk borer.
8. *Wheat from certain countries.* Wheat from any country in Europe and the States of Illinois, Kansas, Washington and Missouri of the United States (as well as from Australia, Asia, Africa and Chile) requires a permit and must be accompanied by a certificate indicating freedom from flag smut (*Urocystis tritici*) in the locality where the wheat was harvested. This certification requirement does not apply to wheat seed imported for scientific purposes.

   Wheat from the States of Washington, Wyoming, Montana, Idaho, Utah, Oregon and New York for scientific purposes is exempted from the certification requirement with reference to dwarf bunt (race of *Tilletia caries*).
9. *Used bags* (*New regulation*). Used bags, slit bags, parts of bags and any used covers of like kind other than paper bags from all countries other than the United States (including Alaska) may be imported only if a permit has been obtained from the Plant Protection Division, and the shipment has been fumigated with methyl bromide in accordance with the approved method or with alternative treatment authorized by the Chief, Plant Protection Division. The shipment must enter through the port of Montreal or Vancouver or any other port designated by the Plant Protection Division.
10. *Root crops* (*New regulation*). Root crops such as horseradish, carrots, beets, parsnips, turnips, mangolds, onion sets, garlic bulbs and bulbils, in raw or unmanufactured state, from all countries except Bermuda, the United States (including Alaska) and the West Indies (including Cuba and the Bahamas) may be imported only if a permit has been obtained from the Plant Protection Division, and the produce is free from sand, soil or earth and packed in new containers. The shipment must enter through a port authorized for the importation of nursery stock and must not be moved from that port unless a certificate of inspection or clearance has been issued or permission has been given to proceed to destination for inspection in the original packing.

Honduras

Plant Protection Law of 31 January 1955, published in *La Gaceta* No. 15508, 1 February 1955, revokes Decree No. 115 of 14 August 1953 and all other regulations which are contrary to the provisions of this Law.

This new Law consists of six chapters. In Chapter I concerning purposes, definitions and powers, the Secretary of Natural Resources is empowered to prohibit the importation, exportation or transit of plants and parts of plants, soils, fertilizers, containers and other items which may disperse pests and diseases; and to apply all necessary measures to combat pests and diseases, including the destruction of plantations and materials which may be involved in their propagation. Chapter II contains provisions whereby the proprietor, user or occupant of land is obliged to report the occurrence, outbreak or suspicion of pests or diseases in his own land as well as in adjacent land, and to co-operate with governmental agencies in investigations and control operations.

Chapter III, relating to importation, transit and exportation, invests the Ministry of Natural Resources with powers to inspect and quarantine any plants, parts of plants, plant products and packings whenever necessary, and to permit any consignment, or restrict, prohibit or destroy any consignment even if accompanied by a phytosanitary certificate. The Ministry may also inspect consignments which are in transit and remain in the territory for more than 48 hours. Seeds, plants and parts of plants for exportation must be inspected by the Department of Plant Protection, which will be responsible for the issue of phytosanitary certificates in accordance with international agreements in this regard. Plant material carrying pests or diseases and living specimens of pests for scientific or teaching purposes, are exempted from the provisions of this chapter but in the case of exports certificates will be issued in conformity with the regulations of the importing country.

Chapters IV, V and VI deal with indemnities, sanctions and general provisions, respectively.

News and Notes

Ireland Ratifies the International Plant Protection Convention

The Government of the Republic of Ireland, whose representative signed the International Plant Protection Convention on 6 December 1951, deposited the instrument of ratification with the Director-General of FAO on 31 March 1955. The number of countries contracting to the Convention, including both signatory and adhering members, is thus, at the time of writing, twenty-eight, namely: Argentina, Australia, Austria, Belgium, Cambodia, Canada, Ceylon, Chile, Denmark, Dominican Republic, Egypt, El Salvador, Greece, India, Iraq, Ireland, Japan, Korea, Laos, Luxembourg, Netherlands, New Zealand, Pakistan, Republic of the Philippines, Spain, Sweden, the United Kingdom and Yugoslavia.

FAO Desert Locust Control Committee

The first session of the new FAO Desert Locust Control Committee met at Rome, 12-16 April 1955, and was attended by representatives of fifteen governments and an observer from the Arab League. In reviewing the progress of the present international campaign in the Arabian Peninsula, in which nine governments are participating actively and to which another six governments are contributing materials or cash, the Committee recorded that, while some excellent progress had already been made in controlling widespread hopper infestations in Saudi Arabia and Kuwait, it was yet too early to assess the full results. While a number of deficiencies and shortcomings still remain to be overcome to make the Arabian campaign fully effective, it was clearly demonstrated that the present campaign was a great advance on that of 1954.

The Committee concluded that there were no signs that the present plague of the desert locust was beginning to decline, and it therefore paid special attention to preparing preliminary plans for the 1955/56 campaign in the Arabian Peninsula. A detailed schedule of requirements was approved and when this has been translated into actual requirements of cash, manpower, supplies and equipment, it is planned to explore how the needs may be met by governments and by FAO at a further conference to be held in July or August of this year.

Roma - Tip. del Senato del dott. Giovanni Bardi

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II Humid Tropics

Forestry Development Paper No. 5. $3.50, 17s. 6d.

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Forestry Development Paper No. 6. $1.50, 7s. 6d.

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